Merced River
Robinson/Gallo Project - Ratzlaff Reach
Engineering Report

California Department of Water Resources
San Joaquin District
River Management Section

Appendix C
FONSI Comments and Responses

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June 18, 1999

Miriam Morrill
U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
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Dear Ms. Morrill:

Thank you for providing me a copy of the Draft Environmental Assessment/Finding of No Significance Impact (EA/FONSI) for the Merced River Salmon Habitat Enhancement Project - Ratzlaff Reach Site. I appreciate the opportunity to comment. My comments fall into two categories: (1) adequacy and appropriateness of the project design, and (2) adequacy of the project monitoring plan.

Project Design

A fundamental assumption of the Service's EA is that the project design will restore natural river dynamics and will improve the active river channel and floodplain. This improvement in geomorphic function is specifically identified as a project benefit in Section 4.3 Hydrology/Water Quality (p. 20) and is implied in the assessment of impacts to Fisheries (Section 4.2.6, p. 14). VICK-1

While, I agree that restoring or rehabilitating channel and floodplain morphology and function in this reach would benefit fisheries and other natural resources, I have serious concerns regarding the project design and question whether this project will, in fact, provide the anticipated benefits. In short, I am concerned that sufficient consideration was not given to existing (regulated) hydrologic conditions, anticipated sheer stress and bed mobility in the constructed channel, or flow depths and velocities (and the effects of flow depth and velocity on riparian vegetation) on the adjacent floodplain. My concerns are discussed in detail in my January 7, 1999 letter to Kevin Faulkenberry of the California Department of Water Resources (attached). Scott McBain, a fluvial geomorphologist with extensive experience in river reiteration and channel design, has also expressed concerns regarding the project design (attached). VICK-2

With these concerns in mind, I recommend submitting this project to a formal peer review process prior executing the FONSI and providing funds. The Ratzlaff Reach project is the first of four phases that comprise the Merced River Salmon Habitat Enhancement Project. It, therefore, will provide momentum to continue with future phases (and investment) and, with VICK-3

adequate monitoring, will provide important information for the design of future projects. The peer review. will help ensure that the project provides the intended benefits (and does not result in unanticipated adverse impacts) and will provide important input for the design and implementation of future projects. Given the importance of the project, the experimental nature of river channel and floodplain design, and the magnitude of public funds invested (estimated at more than 4.3 million), the cost of the peer review process and the time delay that it may incur seem minimal and justifiable.

Project Monitoring

The monitoring program for this phase is extremely critical because it will provide important information for the design and implementation of future project phases. Lacking sufficient monitoring information, it would not be possible to improve future project designs. It is, therefore, crucial that the Ratzlaff Phase monitoring program is both comprehensive and capable of providing data in a sufficient time frame to be useful in the design of future phases.

The physical monitoring program outlined in Appendix B Table I proposes to survey the channel at 5, 10, and 15 years after project completion. It is more appropriate to schedule monitoring surveys relative to high flow events that are anticipated (based on design analyses) to be sufficient to mobilize the channel bed and cause channel adjustment, especially if such high flows occur soon enough after project completion that the monitoring information can be incorporated into the design of future phases. VICK-4

In addition, I recommend adding the following, components to the project monitoring program:

Hydraulics

Computations of floodway conveyance and geomorphic surface design (floodplains and terraces) depend on hydraulic roughness values. Manning's n is typically the toughness variable of choice, and is a function of particle size, bedforms (bars), sinuosity, vegetation, and other channel obstructions. These roughness values are typically estimated by back-calculation from other sites or from professional experience. By monitoring water surface elevations during discreet high flow events immediately after construction, toughness values can be back-calculation using HEC-RAS to compare observed versus design values, which can the n be used to improve future designs. Additionally, floodplain and terrace inundation during discreet high flow events can be evaluated to determine if floodplains were inundated by discharges exceeding the design bankfull discharge and will inform the design of future phases.

Schedule: Monitor water surface elevations during the first high flow after construction that equals or exceeds the design bankfull discharge. VICK-5

Riparian Species Composition and Recruitment

As described in Appendix B, riparian habitat monitoring will assess only one parameter - percent cover by "plant growth." This information, while important, will not be sufficient to provide even a cursory, qualitative assessment of riparian vegetation establishment or riparian habitat function.

For instance, the monitoring might determine that the site achieved 60 percent cover by plant growth; however, from this information it would not be possible to determine whether or to what extent this cover consisted of native riparian species. Furthermore, it would not be possible to determine whether native riparian plants were being naturally recruited to the site, an important indicator of riparian habitat function. At a minimum, the monitoring program should assess percent cover by individual species or species assemblages and should quantify natural recruitment of native woody riparian species.

Schedule: Monitor immediately after construction (year 0) to evaluate planting success and document as-built conditions, at the end of irrigation (usually year 2), in years 3 and 5 (or potentially after a high flow event that exceeds the channel geomorphic design flow and inundates reconstructed floodplains), and in year 9. VICK-6

Please call or e-mail (jen@stillwatersci.com) if you have any questions regarding, these comments. Thank you for your consideration.

Sincerely,

Jennifer Vick

cc w/o enclosures: Scott McBain, McBain and Trush
Scott Spaulding, U.S. Fish and Wildlife Service
G.M. Kondolf, University of California - Berkeley

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January 7, 1999

Kevin Faulkenberry
3374 East Shields Avenue
Fresno, CA 93726

Dear Kevin:

I appreciate the opportunity to review the design documents for the Merced River Robinson/Gallo Project - Ratzlaff Reach (October 29, 1998) and look forward to working with you on the Merced River. I have a few comments regarding the design approach described in the above-referenced report and the implied underlying design assumptions. My comments are summarized below. Please call if you have any questions or -would like to discuss any of my comments.

Design Floodway Conveyance

The current floodway conveyance may preclude or inhibit reasonably anticipated changes in flood management. The current floodway conveyance is designed for 8,000 cfs with two feet of freeboard on the project berms. The recurrence interval of this flood magnitude at Snelling is approximately 12.5 years (based on the relatively shore post-Exchequer Dam flow record of 1968-1997). I assume that this discharge was chosen based on the Board of Reclamation's flood release limitations, which allow Merced Irrigation District (MID) to release up to 6,000 cfs from the New Exchequer Darn. As we have discussed in recent emails, there may be an opportunity for MID to increase its maximum allowable flood releases through the Corps of Engineers. San Joaquin Basin Comprehensive Study process. The opportunity to provide increased flood flows could benefit channel and floodplain conditions at the project site and elsewhere in the lower river. IE would be worthwhile for CDWR to coordinate with MID regarding potential future changes to flood management in the lower Merced River and consider these future changes in the Ratzlaff design. VICK-2A

In addition, while the project berms are designed to withstand flows of 12,000 cfs with minimal damage, it is not clear how the floodplain and riparian habitat as at the project site would function under these higher flows. Under natural conditions, the width of the floodplain on the Merced River allowed flood waters to spread out, resulting in relatively shallow floodplain inundation during high flow events. I am concerned that confinement of the floodplain to a

relatively narrow corridor that is confined by levees (as is proposed in this design) may increase floodplain inundation depths and velocities to an extent that hinders the development of a healthy riparian community. It would be helpful to include a discussion of anticipated floodplain inundation frequency and depth and the riparian community processes that are driven by this inundation in the design report. VICK-2A2

Particle Size Distribution of the Planned Fill Material

The particle size distribution of the planned fill material seems to have been determined based on the size distribution of material occurring at the Blasingame Mine rather than on particle sizes that would be expected to be mobilized under the Merced River's current or anticipated flow regime. Because frequent bed mobilization is a fundamental component of the stated objectives of improving river and floodplain dynamics (objective 4) and creatin a sustainable natural system (objective 6), it would be more appropriate to determine the size distribution of the fill material based on an assessment of shear stresses likely to occur in the reconstructed channel under current (or anticipated) hydrologic conditions.

From the specifications provided on page 4, it appears that the proposed fill material may be coarser than material currently occurring in the reference reach (which has likely already undergone coarsening as a result of interception of coarse sediment supply by upstream dams) (see attached). The d_{50} of the proposed fill would range from approximately 20 to 100 mm, and the d84 would range from Approximately 70 to 200 mm. Material meeting the coarser end of these specifications is much coarser than the bed material documented at your two cross sections and at nearby locations (see attached). Reconstruction the channel with coarser material would likely further reduce the frequency of bed mobilization and would therefore hinder restoration of river and floodplain dynamics and creation of a sustainable natural system. VICK-2B

Particle e Distribution and Mobility in the Reference Reach

The pebble counts conducted in the reference reach documented a broad difference in particle size distribution at the two sample sites, with bed material at XS 28+00 being much finer than at XS 24+00. In 1994, 1 conducted pebble counts at the Snelling Road bridge, the CD Snelling gauge, and the State Route 59 bridge (see attached). The bed material at these sites was similar to that documented at XS 24+00. 1 did not encounter any material as fine as that at your XS 28+00 in this reach. This may be due to site-specific differences and the small number of pebble counts conducted in this reach. This issue, however, warrants further consideration because accurate documentation of particle size d mobility in the reference reach is important to the development of an appropriate channel design. CDWR might consider conducting additional pebble counts in this reach. These counts should be conducted at appropriate channel locations (i.e., locations appropriate for evaluation of bed shear stress and incipient motion thresholds). VICK-2C

Also, the Shields analysis results for this reach indicated that the d of the channel bed would be mobilized at flows of 1,500-1,560 cfs (recurrence interval -1.6 years). Considering that this

reach has had no coarse sediment supply for neatly 75 years and that the bed has likely coarsened substantially, it is doubtful that the existing channel bed is mobilized by the current (post-dam) $Q_{1.6}$. For this Shields analysis, the T^*_{cr}, used was 0.02. This T^*_{cr}, value, however, is much lower than values typically used. T^*_{cr}, for gravel-bedded rivers typically ranges from 0.03 to 0.06, and T^*_{cr} back-calculated from Akagi's tracer particle experiment at Crocker-Huffman Dam ranged from 0.031 to 0.075. (I need to check on the particle sizes she used) Use of a lower T^*_{cr} value would result in underestimation of the bed shear stress (and flow magnitude) needed to mobilize the channel bed. I would recommend reevaluating bed mobility in the reference reach using a higher T^*_{cr}, value. Ideally, CDWR would conduct tracer particle experiments in the reference reach to provide field verification of critical bed mobility thresholds. VICK-2C

Bankfull Flows

The magnitude of the bankfull discharge was estimated using field indicators of the bankfull channel observed at two gauge locations. The discharges corresponding to the stage height of these indicators had recurrence intervals of 1.5-2.5 year. It is unlikely, however, that this discharge is sufficient to mobilize the channel bed or influence channel formation- Upstream dams have reduced the $Q_{1.5}$ in the lower Merced River by 83 percent, from 8,200 cfs prior to the construction of the original Exchequer Dam in 1926 to 1,400 cfs after construction of the New Exchequer Dam in 1967. This reduction in the peak flow magnitude has likely reduced the frequency of bed mobilization. For example, at Crocker-Huffman Dam, tracer gravel experiments indicated that the bed at this location was not mobilized by flows up to and exceeding the $Q_{4.5}$ (Kondolf et al. 1996). The estimated current bankful discharge, therefore, may not be meaningful in terms of the observed channel morphology. VICK-2D

The concept of the bankful discharge is important for the development of the channel design. If the goal is to construct a channel that conveys the bankfull discharge and for which the bed is a mobile at this discharge, a reasonable approach would be to estimate the magnitude of the $Q_{1.5}$-Q_2, then use an appropriate model combined with field verification to identify the channel dimension that conveys this flow and the bed material size that is mobilized by this flow. Recognizing that periodic gravel augmentation will be required to maintain the site (because the bed will be mobile under frequent flows and there is no upstream gravel supply), the project should also include augmentation in the program design.

Relying on flood recurrence intervals to establish a bankfull target can be risky, but in a regulated system this may be appropriate because the objective is to construct a channel that is frequently mobilized and that frequently floods. CDWR, however, might consider coordinating with MID regarding potential management actions that may affect flood frequencies and magnitudes.

It appears that the estimated bankfull discharge was used to develop the channel cross section design, but additional detail of the HEC-RAS analysis would be useful. It does not appear that the bed mobility for this discharge magnitude was considered in the selection of the fill material composition. VICK-2D

Bed Mobility in the Reconstructed Reach

On page 8, the report indicates that bed mobilization may be undesirable due to lack of supply and provides estimates of critical depths calculated using the d_{50}, and d_{84}, (I assume of the proposed fill material). Bed mobilization and sediment transport, however, are fundamental to the project's objectives of improving river and floodplain dynamics and creating a sustainable natural system. Rather than constructing an immobile bed, it would be preferable to construct a mobile bed and include a long-term sediment augmentation pro, at the site to provide a coarse sediment supply. VICK-2E

Monitoring

The proposed, monitoring program includes a channel profile, channel cross sections, and tracer particle experiments. Properly implemented, these measures can provide information on channel migration, change in channel cross section and slope, and sediment transport. This information can be used to evaluate specific hypotheses that underlie channel design, The project, however, includes additional objectives(e.g., reducing predator habitat, improving salmon habitat, and creating a riparian corridor) that should also be evaluated by the monitoring program.

In my opinion, a monitoring program should evaluate (1) whether the physical design aspects of the project have performed as designed (e.g., does the channel convey the design flow, is the bed mobilized at the design flow) and (2) whether the anticipated biological response to these physical design aspects has occurred (e.g., does natural recruitment of native riparian vegetation occur and at what elevations and inundation frequencies does it occur, is salmon habitat improved, is predator abundance reduced). This would require expanding your monitoring program to include more detailed evaluation of the physical design aspects as well as an evaluation of the biological responses. McBain and Trush and Stillwater Sciences worked with the Tuolumne River Technical Advisory Committee Monitoring Subcommittee to develop a comprehensive monitoring approach for a similar project on the Tuolumne River. I would be happy to provide a copy of s monitoring plan to you ro discuss, monitoring design and implementation. VICK-5 &

Sincerely,

Jennifer Vick

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William J. Trush, Ph.D.
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7 January 1999

Kevin Faulkenberry, Department of Water Resources
3374 East Shields Avenue
Fresno, CA 93726

RE: Merced River Robinson/Gallo Channel Rehabilitation Project

Dear Kevin:

Thank you for the opportunity to review your design for the Ratzlaff Reach of the Robinson/Gallo Channel Rehabilitation Project. My comments are summarized below.

FLOODWAY WIDTH AND CONVEYANCE

I am concerned that the floodway width and flow conveyance is under-sized. I certainly understand the expense of increasing the floodway width further into a deep pond; however, I feel that the expense of making a wider floodway will provide additional safety factor for levee longevity and capacity, allow for some channel migration (which is critical for salmon habitat and riparian regeneration), and provide more riparian habitat. In low gradient rivers like the Merced, I think that incorporating the dynamic nature of the river into the design will increase the biological and geomorphic benefit of the project and reduce the risk of "failure." DWR has taken some criticism over the years for reconstruction "failures"; designing for a dynamic system takes away that criticism (i.e., we meant for the channel to migrate and the bed surface to move, so it's not a failure, it's a success) and provides significant biological and geomorphic benefits.

MCB-2F

The design drawing depict a design floodway width typically between 200 and 250 feet; this seems very narrow. We are shooting for 500 ft minimum width through the gravel mining reach on the Tuolumne to convey a design flood of 15,000 to 20,000 cfs (the Corp is presently recomputing flood frequency after the 1997 flood). Your design is a 25 year event, which was read from the flood curve as 8,000 cfs. However, the 25 year flood, as I read from the from the frequency distribution fit curve rather than the data, is actually 13,000 cfs at Cressey and 11,000 cfs at Snelling, rather than 8,000 cfs (I'm assuming a Log Pearson III fit, and it doesn't appear to fit well to the high flow data at Snelling). I think you should include some further discussion of how the design flow was developed (flood frequency, dam outlet works capacity, etc) as it is critical in deciding and designing a floodway width.

Proceeding, these discharges are much closer to the design flow used for the Tuolumne River, and may warrant a floodway width nearer to 400 feet or more. A summary of hydraulic computations and/or HEC RAS output would be helpful as well. I think that the Equalization Saddle is an annotative safety mechanism design for having flow bypass into the ponds during larger flows, and I'll bring them into channel design discussions underway on the Tuolumne

River projects.

REVETMENT

I am not a fan of Rosgen style log-crib revetment structures, particularly where it is not absolutely necessary, and I don't think it is necessary here. These structures (1) inhibit the channel from self-adjusting by attempting to stabilize meander, (2) are contradictory to "Improving river and floodplain dynamics" because they discourage channel migration and floodplain formation, and (3) usually fail eventually leaving large erratic boulders scattered around the river bottom. Not knowing what the bankfull channel may eventually migrate into, perhaps you could place the revetments closer to the base of the levees where you anticipate the channel to eventually migrate to rather than along the low water channel. This would allow the channel to migrate, but only a set distance to protect the levees and any other structures of importance out there. MCB-2G

BANKFULL DISCHARGE ON REGULATED RIVERS

The concept of bankfull discharge works well for the utopian snowmelt streams in the Rocky Mountains where the concepts were developed, and probably the Central Valley rivers before they were managed, but we are faced with the dilemma of "How do bankfull discharge concepts work for intensively regulated rivers?" As you know, functionally all of these rivers have both the coarse sediment supply and channel forming flows reduced to the point where the river cannot re-form its channel dimensions. One of our finds on the Tuolumne River was that in the few areas where agriculture, gold mining, and/or gravel mining didn't redefine channel morphology, the river was a fossilized version of the pre-New Don Pedro (or older) flow regime. Because there is virtually no coarse sediment supply to convert the bed particles to a finer size class, and channel forming flows rarely occur, the channel does not have the sediment supply and transport capacity to redefine its bankfull dimensions. I presumed the Merced is the same way (e.g., I doubt that the 2,300 cfs post-dam flow is sufficient to mobilized anything but sand). This comment may be more of a terminology concept that deserves discussion; the term "bankfull discharge" in its classic hydrological characteristics (approx. 1.5-2.0 year flood) and geomorphological characteristics (floodplains are accessed by flow, and bed surface is fully mobilized) is a term that no longer applies to most Central Valley rivers. Therefore, I try to avoid using the term under existing conditions because it simply does not exist anymore. I would like to see both the channel that Trinity Fisheries Consulting references and your sites, as I am a bit skeptical that post-dam bankfull channel indicators exist on the Merced River. MCB-2H

PARTICLE MOVEMENT CALCULATIONS

I am confused on what your particle movement objectives are. It appears that an objective is to improve river and floodplain dynamics, including bed mobilization (page 3 and 6), but then on page 8 it appears that selective mobility of the D_{20} but not the D_{84} is desired. Second, the analysis should be done on long, straight riffles where DuBoys equation can be reasonably used. Point bars cause secondary circulation, adding additional, significant, and complex shear stress terms onto DuBoys equation (see Dietrich and Whiting 1989 for the gory details). Even in straight reaches momentum transfer to the channel banks causes significant variation in local shear stress across the channel that vary by a factor of 1.5 to 2 compared to the average value predicted by the DuBoys equation. Do you have a long, straight riffle that you can use? Third, the dimensionless critical shear stress is a function of particle size and grain-to-grain interaction (particle hiding and protrusion). The entire distribution of coarse sediment is mobilized within a MCB-2I

fairly narrow window of shear stresses (and discharges) because of hiding of smaller particles and protrusion of larger particles. This is reflected in most contemporary bed mobility models (see Andrews 1994, Wiberg and Smith 1987, Parker 1982, etc). In general, for gravel-bedded streams, dimensionless critical shear stress values range from 0.02-0.025 for the D_{84} and 0.03 to 0.045 for the D_{50}. The larger values are obtained when using the effective, width of the channel to compute hydraulic radius, and the smaller values are obtained when using the effective width of the channel to compute hydraulic radius. A value of 0.02 cannot be applied to the D_{50}. I suggest using the D_{84} and a dimensionless critical shear stress of 0.02. Using a conservatively mobile dimensionless critical shear stress of 0.02 for the D_{84} slope of 0.0014, and D_{84} particle size of 105 mm (average of the two cross sections), the hydraulic radius at incipient motion would be 8.13 feet. Using a value of 0.025 increases the depth to 10 feet. Doing the same for the D_{50} (using a D_{50} of 55 mm and dimensionless critical shear stress of 0.03 and 0.045) results in hydraulic radius estimates of 6.4 ft and 9.5 ft. In summary, I think that you should clearly state what the bed mobility objectives are, and re-evaluate the bed mobility predictions for riffle cross sections only using revised dimensionless critical shear stress values. I would be happy to discuss this with you and forward additional bed mobility models that predict dimensionless critical shear stress values. MCB-2I

MONITORING

Monitoring should do the following: (1) document whether objectives being met, and (2) test hypotheses used to develop the design. Each monitoring component should be, explicitly linked to project objectives and hypotheses. The link between project objectives and the monitoring plan is weak, and there are no stated hypotheses so the monitoring plan doesn't appear to test hypotheses either. The CALFED monitoring group will be looking for this if they are reviewing this project. Some suggested objectives that are easy to monitor for and quantify are: MCB-2J

- -Floodplains will inundate at X cfs (bankfull channel design needs re-evaluation)
- -The D_{84} particle size will begin mobilizing at Y cfs (should be slightly lower than design bankfull channel elevation)
- -Salmon predator habitat will be reduced (e.g., surficial area of habitat or weighted usable area)
- -Salmon spawning and rearing habitat will be increased (e.g., surficial area of habitat or weighted usable area)
- -Riparian vegetation coverage will increase (e.g., surface area, species diversity)

More, difficult objectives may include:

- egg-to-emergence success will increase, increasing salmon production
- increased and improved rearing habitat will increase, salmon production
- reduced bass predation will increase salmon production
- channel reconstruction and periodic adjustment will increase habitat diversity and complexity

Lastly, there will be heartburn to a large contingency of evaluators to the phrase "These monitoring actions...will allow engineers to assess the effectiveness of the design with respect to the project goals" since much of the funding impetus for this project is biological. There is no biological or riparian monitoring currently in the plan, and there should be.

MISCELLANEOUS

- Page 3. 1 got hammered by peer reviewers recently for implying that a river disturbed by

flow and sediment regulation is "un-natural". Their point that the river is adjusting to a changing flow and sediment regime by being fossilized by riparian vegetation along the margins, coarsening the bed surface, and potentially narrowing, all of which is a natural ecological response to human manipulation of the system.

- Page 8. I could not find any design width numbers, although it is mentioned at the bottom of page 8 and top of page 9. There is a section called "Development of Typical Sections", but there is no summary table or figure to show what they are. A cross section template for pool and riffle morphologies would be helpful, Also, as mentioned above, documentation of the reference reach to help me interpret its geomorphic attributes would be helpful. MCB-2K
- A designer and/or contact person on the cover would be helpful.

I hope this helps you refine the design as many of the points brought up above are difficult design cons4iderations that I continually struggle with wh, en preparing channel rehabilitation designs. I would be happy do discuss these comments in more detail at your leisure.

Sincerely,

Scott McBain

REFERENCES

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Dietrich, W. E. and P. Whiting (1989). "Boundary shear stress and sediment transport in river meanders of sand and gravel." American Geophysical Union: 1-49.

Park G., P. C. Klingeman, et al. (1982). "Bedload and size distribution in payed gravel- bed streams." Journal of Hydraulics Division, Proceedings of the American Society of Civil Engineers 108(No. HY4, April): 544-571.

Wiberg, P. L. and J. D. Smith (1987). "Calculations of the critical shear stress for motion of uniform and heterogeneous sediments." Water resources research 23(8): 1471-1480.

Ratzlaff Reach Restoration Project Comments, Part II
Prepared by Scott McBain, McBain & Trush, 10 September 1999

There are three significant issues that this commentary addresses: Floodway width, hydraulics, and peer review.

Floodway Width and "Conveyance"

CDFG and DWR continue to frame the design as a difference of opinion over the design floodway conveyance (8,000 cfs vs. 12,000 cfs). This is only a portion of my concern with the design. My conveyance concerns were two-fold: 1) if the 25-year flood is used as the design criteria, interpolation from the flood frequency curve appears erroneous as noted in my January 1999 comments, and 2) even though the MID is not planning on releasing 12,000 cfs, mother nature does not always recognize the desires of the MID or the jurisdiction of the Army Corps of Engineers. I realize that there is significant constraints to release 12,000 cfs, but someday it will happen, and we should embrace the environmental benefits of it and consider designing for it.

As I stated during the August meeting in Stockton, the size of the project is not simply a matter of floodway conveyance. A dynamic channel is key to creating and maintaining high quality salmon habitat, as well as riparian vegetation and its associated terrestrial habitats. Therefore, a dynamic channel needs space to be dynamic, since dynamic includes downstream movement (bed mobility/transport) and lateral movement (channel migration and floodplain formation). A narrow floodway, bank revetment, and large particle size discourage a dynamic channel during low to moderate floods (e.g., present-day bankfull discharge), yet encourage catastrophic damage to the channel during large floods. The 1997 flood on the Tuolumne River is a case-in-point. In locations where the floodway was confined by riparian encroachment or dikes, the confinement was analogous to pinching a garden hose; entire pool-riffle sequences were scoured away, to be deposited as massive aggradational lobes where the dikes eventually failed. This happened on the M.J. Ruddy 4-pumps restoration project, causing a nearly complete failure of the project at a cost of over a million dollars. We face the same risk on the Ratzlaff Project. The design approaches that failed on the Tuolumne River are still being applied to the Merced River, with the caveat of "future maintenance". Why can't we strive for a maintenance free project? What have we learned from the 1997 flood and earlier project failures?

Hydraulics

Three issues are significant: impact of "wetland" area on shear stress and sediment transport/deposition processes, longitudinal slope breaks, overly large particle size, and "bankfull" discharge. There is no discussion of what the objective of the wetland area is. If the intent of the wetland area is to reduce the volumne of material, it does so at the expense of sediment transport continuity because the break in channel confinement causes a dramatic decrease in boundary shear stress. During high flows, coarse sediment

in transport will rapidly deposit in this location, burying the spawning riffle and potentially localized braiding. This may be the source of the immediate decrease in longitudinal energy grade at station 14+00. The energy slope (which is driving shear stress) decreases from one-half to one-third the upstream values. An existing and proposed thalweg profile would illustrate how the project is going to redistribute slope, and help identify potential problems of the design restoring a natural pool-riffle sequence.

The "bankfull" discharge (1,700 cfs) and large D84 particle size guarantees that the bed surface is not mobilized by the bankfull discharge. If the intent of the "bankfull discharge" is not to move the D84 particle size (apparently 170 to 200 mm), then the bed mobility analysis can simply be deleted, and project objectives adjusted accordingly, and we shall move on with another semi-static channel.

Peer Review Process

The issues of design philosophy, design criteria, design calculations, and previous design failures/successes are all components of a healthy, collegial peer review process. The intent of the peer review process is to make the project better, not simply to avoid negative impacts (as implied in the Summary of CDFG's 8/19/99 letter). Additionally, while technical and philosophical differences do occur, the peer review process identifies them, providing the ability for monitoring and adaptive management to resolve these differences. In the absence of this peer review process and adaptive management, the status quo is virtually guaranteed to continue. Additionally, as this project has illustrated, simply soliciting comments is no substitute for the peer review process. A preferable peer review process that should be adopted by both CALFED and AFRP would include:

1) a rigorous peer review process by qualified specialists that are financially and politically disinterested in the project,
2) mandatory response to comments by the project proponents prior to beginning the final design drawings/specifications, including a proposed monitoring/adaptive management program to address differences of opinion, and
3) a contractual obligation of the project proponent by the funding source that peer reviewer comments are adequately addressed before construction funding is released.

19 August 1999 CDFG letter

A few thoughts regarding the 19 August 1999 CDFG letter. First, it states that technical input "was incorporated into the final design where appropriate," but it is not apparent in the latest iteration of the design that anything was changed, other than removing revetment (a product of the 26 August meeting rather than our January comments). Second, it appears that many/most of our comments were dismissed because we could not "identify unanticipated adverse impacts that have not been addressed adequately in the CEQA document/permit conditions" (see first and last paragraphs on p. 4). My comments (as well as Jen Vick's) were not indended to identify adverse environmental impacts; rather they were striving to:

1. Improve project performance
2. Reduce maintenance needs in the future
3. Increase and improve environmental/habitat benefits
4. Ensure that project objectives meet the objectives on the respective funding sources

Lastly, the letter states that areas of technical concern "are predicated by existing social, institutional, and economic constraints and not strictly driven by theoretical application of fluvial theory." This attempts to dismiss legitimate concerns with the technical design and computations by "trumping" them with these percieved constraints. More time should be spent developing ways to cooperatively reduce constraints rather than adhering to the same old narrow constraints. The salmon depend on it, or they will never recover!

Because project construction is already underway, stopping the project at this point would result in even more problems that if it was only half built. Until a more rigorous discussion of restoration philosophy and design can be conducted, the revetment structures should be removed (done), rip-rap at downstream end of project (as described verbally during 26 August meeting) should be deferred, and the "wetland" should be filled to a floodplain during this construction season.

State of California - The Resources Agency GRAY DAVIS, *Governor*
DEPARTMENT OF FISH AND GAME
http://www.dfg.ca.gov
SAN JOAQUIN VALLEY AND SOUTHERN SIERRA REGION
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August 19, 1999

Mr. Dale A. Pierce, Acting Field Supervisor
United States Department of Interior
Fish and Wildlife Service
Sacramento Fish and Wildlife
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

Dear Mr. Pierce:

Subject: Response to Comment Letter, June 18, 1999, from Ms. Jennifer Vick, on Draft Environmental Assessment, Anadromous Fish Restoration Program Merced River Salmon Habitat Enhancement Project Ratzlaff Reach Site

As the State lead agency for the Merced River Salmon Habitat Enhancement Project, Ratzlaff Reach Site (Ratzlaff Project), the Department of Fish and Game (Department) appreciates the opportunity to assist the US Fish and Wildlife Service in addressing concerns raised by Ms. Jennifer Vick, Stillwater Ecosystem, Watershed & Riverine Sciences (Stillwater). At this time, the Ratzlaff project is fully compliant with all pertinent state and federal requirements for the State to complete the project construction this year. Subject Draft Environmental Assessment represents an effort toward compliance with the National Environmental Policy Act associated with potential federal cost sharing reimbursement on the project. We received no similar letter of comment from Ms. Vick in response to the Negative Declaration prepared by the Department on this project pursuant to the California Environmental Quality Act in March of this year. Her concerns focus on a request for further peer review of the project design, greater consideration given to unique hydrologic conditions and effects on sheer stress, bed mobility, flow depths and river velocities. These are defined in her January 7, 1999 letter along with recommended modifications for project monitoring.

Adequacy of Project Design: Peer Review

Ms. Vick recommends that this project be subject to formal peer review poor to proceeding with the Findings of No Significant Impact (FONSI) for the project. A formal peer review may be useful for assessing the technical validity of a project when an industry standard of care exists. However, as Ms. Vick identified (page 2), the discipline of river channel and floodplain design is experimental in nature. Thus the standard of care is not well defined and a formal peer review likely will underscore the diversity of opinions among

experts in the field of fluvial processes rather than providing a clear analysis of the technical design or ensuring to any greater degree that the project provides the intended benefits. In the interim the regulatory agencies must provide as they have for this project, permit conditions to avoid impacts to resources within their respective jurisdictions.

No unequivocal rules of instream project designs exist. The best accepted practices and criteria to effectively accommodate the design needs at the Ratzlaff project site were applied by the State. It is critically important that the project design staff be knowledgeable and also to communicate with outside experts for professional advice to determine the optimum design criteria. These criteria include consideration of fish habitat, fluvial processes and a broad array of operational, flood control, and landowner issues. In the course of designing this project and obtaining the necessary permits and CEQA compliance, Mr. Kevin Faulkenberry, Associate Engineer with the California Department of Water Resources (DWR) requested input and view of preliminary designs from experts in the field, including Ms. Vick, Mr. Scott McBain, with McBain and Trush, Associates, and Ms. Kris Viberberg, Associate Hydraulic Engineer with the Department, as well as other engineers within DWR. These experts raised a variety of concerns, some of them conflicting. This valuable input was incorporated into the final design where appropriate. Related experts from other agencies and entities were also consulted in the design process, sometimes as a response to a comment raised by another expert. DFG-2

We are aware that Mr. Faulkenberry did communicate with some reviewers regarding their evaluations and changes were made to the project design. Written responses were not provided. So it is reasonable that Ms. Vick or other reviewers may be unaware of these decisions and it is clear that the Department could provide more formal responses to comments. It should be noted that, in response to Ms. Vick's verbal concerns regarding flow design criteria prior to the CEQA process, a meeting was convened on February 18, 1999 to discuss her concerns. Those represented included the Department, DWR, Merced Irrigation District, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Stillwater and the Tuolumne River Preservation Trust. At this meeting Ms. Vick explained her concern that using 8,000 cfs as the flood event design criterion was erroneous and that it was selected without coordination with the COE, Merced Irrigation District, or Merced County on potential new floodplain criteria. Mr. Faulkenberry and others explained the rationale for this design criterion (discussed below) and she was informed how the entities in question and others had indeed been involved in that decision-making process. Ms. Vick did not raise any other issues for discussion at that time and no formal responses were forwarded.

We believe that, because of the extensive consultation with outside experts in the development of the project design and the criteria now used by permitting agencies, a formal peer review process would provide little additional benefit at this juncture in your NEPA compliance for the Ratzlaff Project. We do however, recognize that the review process, one which incorporates tenets of adaptive management, can be improved considering that the "state of the art and science" is changing and that large expenditures of public funds are anticipated for similar projects in the near future. Should peer review prove prudent in the future, I believe it should clearly focus on providing timely DFG-3

geomorphic/fluvial design criteria for permitting and lead agency consideration. It is important to recognize that the three primary areas of concern in the project design to Ms. Vick (consideration of hydrologic conditions, sheer stress and bed mobility, and flow depths and velocities) are predicated by existing social, institutional and economic constraints and not strictly driven by theoretical application of fluvial theory. Thus, concerns may be well suited for permitting agency consideration if they are clearly defined and have a sound technical and practical basis for application. DFG-2

Project Design - Consideration of Hydrologic Conditions

In her January 7, 1999 letter to Mr. Faulkenberry and in subsequent conversations, Ms. Vick has expressed the opinion that the project should be designed for flood flows of 12,000 ds. This is the maximum, controlled rate of release possible from the New Exchequer Dam. Through extensive coordination with Merced Irrigation District, we are aware that they have good reason to avoid planned operations at this high flow level. Indeed, the US Army Corps of Engineers (COE) presently limits the allowable discharge to 6,000 ds. Ms. Vick suggested in her January 7, 1999 letter that the opportunity to increase these flows (implicitly to 12,000 ds) was likely through the COE Sacramento-San Joaquin Basin Comprehensive Study (Study). Communication from Mr. Ron Milligan, COE to Mr. Faulkenberry indicated that while allowable flood releases might increase as a result of the Study, 12,000 ds is not likely to be selected, owing to the expected damage which would result. For perspective a 12,000 cfs flow on the Merced River floods the town of Snelling, Merced River Hatchery, may jeopardize highway bridges, causes seepage and flooding of agricultural lands along the river, may flood the Hopeton school, and threatens some Merced Irrigation District infrastructure at a minimum. Further, the Study flood models indicate that flood stage releases of 12,000 cfs from the Merced River could result in substantial adverse downstream flooding on the main stem San Joaquin River. While 12,000 cfs may be the highest controlled flows possible from the New Exchequer Project, the practicality of using this number as a floodway criteria, or project design criteria, needs considerable development, review and probably an EIS by the COE and an EIR by the State Reclamation Board to adopt. The Department understands the importance of and will be participating in the evaluation of alternative flood flow strategies in the San Joaquin Basin, and on this section of the Merced River. However, given the current practicalities of the flood flow situation, Ms. Vick's recommendations provide no substantive reason for stopping or delaying your NEPA compliance. DFG-2

The Ratzlaff project is designed to develop a flood plain to accommodate an 8,000 cfs flow, which does allow for a future increase from the currently permitted 6,000 cfs. In practicality, this figure was tested in 1997 when the Merced Irrigation District took emergency action during a flood event. Based on their map information, negligible damage would occur at releases of 8,000 cfs for three months. The District's assumptions regarding floodplain capacity and damage minimization were reasonably supported (Mr. Ted Selb, Pers. Comm). While the project flood plain is scaled for an 8,000 cfs event, the project berms will not preclude passage of a 12,000 maximum release within the present footprint of the project area. Although some damage to the project berms would be

expected, a maintenance program has been built into the project for 40 years. Based on the limited likelihood of such a large release, the predicted cost of conducting repairs to the project is far less than the cost of constructing the project to accommodate a 12,000 cfs flow. Of crucial importance, landowner acceptance of this Ratzlaff Project design was predicated on this basis. Ms. Vick's comments specifically do not identify any significant adverse environmental impact resulting from the project design. DFG-3

Project Design: Sheer Stress and Bed Mobility

In Ms. Vick's letter she expresses a concern that anticipated sheer stress and bed mobility in the constructed channel do not allow for sufficient bed mobility. From a theoretical perspective, we would concur, the channel design is deliberately conservative to make a more stable channel than one would probably desire in a natural system without water storage structures. The current design does allow more bed mobility than what presently occurs. The imported material used in the construction is natural riverine material that has been disturbed by gold mining. The conservative channel design was done to accommodate existing land uses and concerns expressed by neighboring landowners. Ms. Vick has not identified that a conservative design may result in a significant adverse environmental impact. The adaptive component of this project allows us to adjust to sediment transport needs at this site in the future, once the channel form is stabilizing from the changes.

Project Design: Flow Depths and Velocities

Ms. Vick's concerns regarding flow depths and velocities appear to be best treated as potential experimental design criteria for the future. Again the COE Sacramento-San Joaquin Basin Comprehensive Study appears to be the best venue for Ms. Vick's concepts to be explored more thoroughly. The Ratzlaff project design flow of 8,000 cfs is estimated to be a 25-year event, and depths and velocities similar to that expected on the project reach are not unheard of on other reaches of the river. We have to remember that we are restoring limited function to the flood plain and channel which, in its present state, may have been dredged down to near bedrock, leaving little of its former natural function. The intent of the project is not to create what existed prior to mining disturbances but to improve riverine habitat and function within existing social, institutional and economic constraints over a specified time.

Project Monitoring

We concur that project monitoring is critically important. The monitoring surveys Ms. Vick suggested relative to high flow events are, in fact, included in the monitoring plan (Appendix B, page B-4). We concur that water surface elevations should be included in the hydraulic evaluations. The monitoring plan associated With and funded through the federal cost share reimbursement should incorporate that recommendation. DFG-4 DFG-5

The riparian vegetation monitoring presently meets the required standards for the COE permitting requirements. However, from an ecological function perspective, per cent cover by species and recruitment are valuable additional parameters. These factors should be incorporated into the monitoring program as federal cost share reimbursement DFG-6

funding will allow.

Summary

We appreciate the suggested modifications to the monitoring program for this State project. Those changes could be incorporated as federal funding will allow. The concerns raised regarding project design appear to stem from a disparity of professional opinion between what a theoretical solution may demand and what the reality of the existing societal and infra structural situation requires. Given the current standard of care for this type of work required by permitting agencies and the high level of consultation involved in the project design, it is unlikely that a peer review process would identify unanticipated adverse impacts that have not been addressed adequately in the CEQA document/permit conditions. Ms. Vick's comments provide some useful input, but do not identify any significant adverse environmental impacts. The Department recommends that the U.S. Fish and Wildlife Service proceed with the August 26, 1999 meeting to discuss the concerns raised. Absent a clear delineation of significant environmental impacts specific to the Ratzlaff project, we encourage you to proceed with the proposed Finding of No Significant Impact associated with the federal reimbursement participation in this approved State project.

Sincerely,

W. E. Loudermilk
Acting Regional Manager

cc: Mr. Randy Brown, DWR
Mr. Lou Beck, DWR
Mr. Tom Coe, USACE
Mr. Pete Rabon, The Reclamation Board
Mr. Dennis Wescott,
Regional Water Quality Control Board
Mr. Ross Rogers, Merced Irrigation District
Mr. Robert Smith, Merced County Planning
Dr. Marty Kjelson, U.S. Fish and Wildlife Service
Mr. Terry Mills, CALFED

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GRAY DAVIS, Governor
DEPARTMENT OF FISH AND GAME
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November 23, 1999

Mr. Dale A. Pierce, Acting Field Supervisor
United States Department of Interior
Fish and Wildlife Service
Sacramento Field Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

Dear Mr. Pierce:

Subject: Response to Comment Letter, January 7, 1999, from Mr. Scott McBain, Relating to Draft Environmental Assessment, Anadromous Fish Restoration Program Merced River Salmon Habitat Enhancement Project Ratzlaff Reach Site

In our previous letter (August 19, 1999) relating to the subject draft environmental assessment (DEA) we did not specifically address the subject letter, as it was provided substantially before the DEA was prepared. However, your staff has requested that, as this letter was referred to in Ms. Jennifer Vick's letter of June 18, 1999 commenting on the DEA, the Department of Fish and Game, as the State lead agency for this project, also respond to the comments of Mr. McBain's letter. Accordingly, Attachment I to this letter is a summary of those responses.

We are pleased that your staff has indicated that on receipt of this final information they expect to complete the Environmental Assessment and move forward with participation in this project. If we can be of further assistance, please contact Ms. Rhonda Reed, Anadromous Habitat Restoration Coordinator of my staff, at (559) 243-4005 extension 172.

Sincerely,

W. E. Loudermilk

W. E. Loudermilk
Regional Manager

Attachment

cc: See page two.

cc: Mr. Randy Brown
Department of Water Resources

Mr. Lou Beck
Department of Water Resources

Mr. Tom Coe
U. S. Army Corps of Engineers

Ms. June Deweese
U. S. Army Corps of Engineers

Dr. Marty Kjelson
U. S. Army Corps of Engineers

Mr. Terry Mills
CALFED

Mr. Pete Rabon
The Reclamation Board

Mr. Ross Rogers
Merced Irrigation District

Mr. Robert Smith
Merced County Planning

Mr. Dennis Wescott
Regional Water Quality Control Board

ATTACHMENT I
Response to Letter From McBain & Trush of January 7, 1999 Relating to Draft Environmental Assessment, Anadromous Fish Restoration Program
Merced River Salmon Habitat Enhancement Project
Ratzlaff Reach Site
November 22, 1999

RESPONSES TO:

PARTICLE SIZE DISTRIBUTION AND MOBILITY IN REFERENCE REACH COMMENT VICK/ MCB-2C

> "I have not encountered any material as fine as that at your XS 28+00 in this reach. DWR might consider additional pebble counts in the reference reach. These counts should be conducted at appropriate channel locations."

We have conducted further pebble counts in this reach and determined that the additional counts are much larger. It is likely that the area sampled was not as significant as once thought, in the context of bankfull discharge. The material in the Robinson reach has a D50 of 65mm to 67mm and a D84 of 120mm to 123mm, which are closer to those sampled in earlier investigations. DFG-7

BANKFULL FLOWS COMMENT
VICK/MCB-2D

> "It is unlikely that the current 1.5 to 2.5 year discharge you used to find bankfull indicators is sufficient to mobilize the channel bed or influence channel formation. For example the tracer gravel experiments below Crocker-Huffman Dam indicated that the bed at this location was not mobilized by flows up to and exceeding the Q4.5. The estimated current bankfull discharge therefore may not be meaningful in terms of the observed channel morphology." DFG-8

The indicators found were subtle and few. Those which were found, however, indicated a remarkably consistent flow for the two gages. And unlike the site below the Crocker-Huffman Dam, which is only a few hundred feet from a dam (which allows absolutely no recruitment of gravel and is constantly bombarded by sediment-hungry water), the gages are several miles downstream, between which are more opportunities for gravel recruitment from banks and bars. We believe that the site does exhibit some indicators of a channel forming nature.

> "A reasonable approach would be to estimate the magnitude of the 1.5 to 2 year flow, then use an appropriate model combined with field verification to identify the channel dimension that conveys this flow and the bed material size that is mobilized by this flow."

The bankfull channel dimensions were identified or confirmed after a bankfull flow was

estimated. Gravel augmentation with more mobile material is planned to replace the mobilized bed.

FLOODWAY WIDTH AND CONVEYANCE COMMENT
MCB-2F

> " I am concerned that the floodway width and flow conveyance is undersized. I certainly understand the expense of increasing the floodway width further into a deep pond; however, I am feel [sic] that the expense of making a wider floodway will provide additional safety factor for levee longevity and capacity, allow for some channel migration (which is critical for salmon habitat and riparian regeneration), and providemore riparian habitat."

The floodway conveyance is for 8,000cfs(33 yr) DWR storm, the same storm frequency conveyed by the habitat restoration projects in the Tuolumne River Gravel Mining Reach 15,000(33 yr), ACOE 1999. We also believe that this is an adequate level of protection for the Merced River as well as the Tuolumne River. Further, the neighboring landowners will accept the level of channel migration allowed for in this design. Should the levee require maintenance during the 40 year life of the project, funds are set aside for that purpose. DFG-9

> "The design drawing depicts a design floodway width typically between 200 and 250 feet; this seems very narrow. "

Actually the floodway is a minimum width of 250 feet and ranges up to 350 feet. This can be confirmed by taking measurements on the drawings or evaluating the HEC-RAS model provided.

> "We are shooting for 500ft. Minimum width through the gravel mining reach on the Tuolumne to convey a design flood of 15,000 to 20,000cfs (the Corp is presently recomputing flood frequency after the 1997 flood)".

The project on the Tuolumne has similar hydraulic characteristics and design parameters. The average design slopes of the Merced and Tuolumne are 0.0015 and 0.0014 respectively and have similar characteristics. With this being said project size and floodplain width should be proportional to changes in flow. If 400 - 500ft is adequate for 15,000 (33yr, ACOE new number) to 20,000cfs then 250 - 350 ft should be adequate for 8,000cfs (33year). The projects will have similar inundation depths(2.0 to 6.0ft) and velocities (0-3 ft/sec) on the floodplains.

> " Your design flood is a 25 year event, which was read from the flood frequency curve as 8,000 cfs. However, the 25 year flood, as I read from the frequency distribution fit curve rather than the data, is actually 13,000 cfs at Cressey and 11,000 cfs at Snelling... etc. I think you should include some further discussion of how the design flow was developed."

The design flood event is actually closer to a 33 year event (50 year event at New Exchequer Dam, ACOE 1999) when the plotted data is observed and not the line created by a log - Pearson Type III. The log - Pearson Line has been removed from future versions of the graph for clarity.

Further discussion of the development of the design flow can be found in the letter from DFG to FWS on the subject of Jen Vick's comments on the FONSI.

REVETMENT COMMENT
MCB2G

> "I am not a fan of Rosgen style log-crib revetment structures, particularly where it is not absolutely necessary, and I don't think it is necessary here."

DFG-10

It is true that in a project consisting of a wide floodplain with bluffs on either side to contain the river, log revetment to help the bank resist channel migration would not be necessary or desirable. The Ratzlaff reach, however, is a pond isolation project consisting of a floodplain and berm separating the channel from the pond. In this case it is necessary to minimize channel migration in sections where the channel might migrate too close to the berm. On further review the placement of some of the revetment structures was deferred to a time when adaptive management determines it to be necessary.

BANKFULL DISCHARGE ON REGULATED RIVERS COMMENT
MCB-2H

> "In general, for gravel-bedded streams, dimensionless critical shear stress values range from 0.02-0.025 for the D84, and 0.03 to 0.045 for the D50. A value of .02 cannot be applied to the D50."

On re-evaluation of the particle movement calculation included in the draft it was concluded that inappropriate shear stress values were applied to the reference reach.

DFG-11

We believe that the material placed during this construction will be more mobile than naturally deposited material and therefore we have used a lower value for critical shear stress. It is believed that after the river has one or two threshold events it will become armored and more stable. But this will not occur without loss of material that will be replaced with gravel additions at a later date. It is our intent that material will be replaced as determined to be necessary in the context of adaptive management.

> "I think that you should clearly state what the bed mobility objectives are, and re-evaluate the bed mobility predictions for riffle cross sections only using revised dimensionless critical shear stress values."

Stated objectives: "improving" does not necessarily mean frequent bed mobility, and the reference to a sustainable natural system was reworded for clarity. Due to economic constraints the sizing of gravel was not based on the design, but rather was checked against the design for premature movement and stability. Appropriately sized material will be placed over time within the scope of the maintenance plan. Adaptive management will identify areas of concern for repairs, changes and locations for a periodic replenishment of coarse material. DFG-11

Each objective, although important, is not mutually exclusive of the others. Stability of this reach of the river channel is important to maintaining other goals and objectives and a balance has been met for all. Objectives are all met and insured by the overall stability of the project.

Revised Goals of the Project are:

1. Eliminate or isolate juvenile salmon predator habitat.
2. Increase the quantity and quality of spawning habitat for Chinook salmon.
3. Increase the quantity and quality of rearing habitat for Chinook salmon.
4. Improve river and floodplain dynamics by reconfiguring the channel to better conform with the present flow regime.
5. Create and enhance the riparian corridor.
6. Create a more natural stream and improve sustainability.

PARTICLE MOVEMENT CALCULATIONS COMMENT
MCB-2I

DFG-12

This topic has been addressed in past correspondence and data exchange with both Scott McBain and Jen Vick.

MONITORING COMMENT
MCB-2J

DFG-13

A more complete monitoring plan is available in the EA and is currently being modified in response to comments received.

MISCELLANEOUS COMMENTS
MCB-2K

"A cross section template for pool and riffle morphologies would be helpful." DFG-14
Significant detail was given to define the pool and riffle morphology in the supplemental information provided.

Appendix D
Construction Report